WHAT IS THE PRIMARY SOURCE OF THE MORPHOLOGICAL SEGREGATION?

S. ANDREON
Osservatorio di Capodimonte, via Moiariello 16,
80131 Napoli, Italy
E-mail: andreon@na.astro.it

In Coma and two other clusters of galaxies the primary morphological segregation is the one with respect to a privileged direction. Only when this segregation is not considered it appears that the morphological types are segregated in density or in clustercentric distance.

1 Introduction

In 1880, Wolf first noted the existence of a segregation of nebulae of different types toward the Virgo cluster. In 1926, Hubble & Humason (1926) recognized the general tendency for Es to reside in the core of clusters. Dressler (1980) and Dressler et al. (1997) claim that the morphological types are primarily segregated in galaxy local density, whereas Whitmore, Gilmore & Jones (1993) claim that they are segregated with respect the clustercentric distance. However, as stressed by Sanromá & Salvador-Solè (1990) and by Dressler et al. (1997), galaxy density and clustercentric distance are almost degenerate in galaxy clusters, except perhaps in irregular clusters, so any correlation with one of these quantities is likely to be also found with the other one.

The existence of a observational relation between galaxy properties and environment imposes the existence of a physical mechanism relating galaxies and environment. The exact nature of the morphological type segregation, in density, in clustercentric radius or in whatever parameter, gives us informations on the nature of the physical mechanism producing the observed change in the morphological composition of the clusters. A clustercentric segregation points out a global mechanism, whereas a segregation with respect to the local density a local one.

Fig. 1 shows the morphology–density (left panels) and the morphology–clustercentric distance (right panels) relations. Points mark our data for a complete sample of ~ 200 galaxies in Coma (Andreon et al. 1996, 1997), lines in the left panels present the morphology–density relation as determined in 10 nearby centrally concentrated clusters (Dressler et al. 1997), including Coma. Lines in the right panels show the morphology–clustercentric distance relation as determined by Whitmore, Gilmore & Jones (1993) on 55 nearby clusters (again including Coma). In the plot, Dressler density units are transformed

in our ones by means of both estimates for Coma galaxies in common. Our sample is as deep as those of Dressler (1980 and 1997) and Whitmore, Gilmore & Jones (1993) and it is complete in absolute magnitude, whereas nothing is known on the completeness of the two comparison samples. Our sample is corrected for background/foreground interlopers removing galaxies with very high velocity relative to the cluster center, whereas both comparison samples are background/foreground statistically corrected because of the scarcity of redshift measurements for these samples. Our estimate of the morphological type of Coma galaxies is at least as good as other ones (Andreon & Davoust 1997), as indirectly confirmed also by Smail et al. (1997) and Dressler et al. (1997) which use our morphological types for confirming the quality of theirs. Shortly, our sample is smaller, because composed by just one cluster, but at least as accurate as the comparison ones.

First of all, we note that our measurements of the morphological segregation have large errorbars. This is unavoidable for all studies concerning just a single cluster, because of the limited number of galaxies in a given cluster. It is for this reason that, in general, the morphological segregation is studied "mixing" data from many clusters.

In the studied range of densities of clustercentric distances of Coma, our points (and likely also all other determinations for any single cluster) are, given the large errors, compatible with all believable changes of the morphological composition with radius or clustercentric distances, including the universal morphology–density and morphology–clustercentric distance relations (the lines in our graphs) and also with no morphological segregation at all (horizontal lines in our graphs). A statistical approach (Andreon 1996) shows that for our sample of Coma galaxies, the radial and density distributions are statistically indistinguishable from a morphological types to another one. The same holds for the Perseus (=Abell 496, Andreon 1994) and Cl0939+4713 (=Abell 851, Andreon, Davoust & Heim 1997) clusters. Therefore we have no evidences for a segregation among the morphological types, in these three clusters on the basis of the above samples.

A much stronger, statistically significant, morphological segregation, but of another kind, is instead present *in the same sample*. Using the same Coma galaxies, we are able to put in evidence a segregation with respect a privileged direction, since many (but not all) morphological types show an elongated spatial distribution along (or orthogonal to) this privileged direction (Andreon 1996). Since for a fixed sample we have detected a relation with respect to a variable (a privileged direction), but not with respect to another one (the density or clustercentric distance), then the former relation is stronger that the latter. We found a similar result for Perseus (Andreon, 1994) and Cl0939+4713

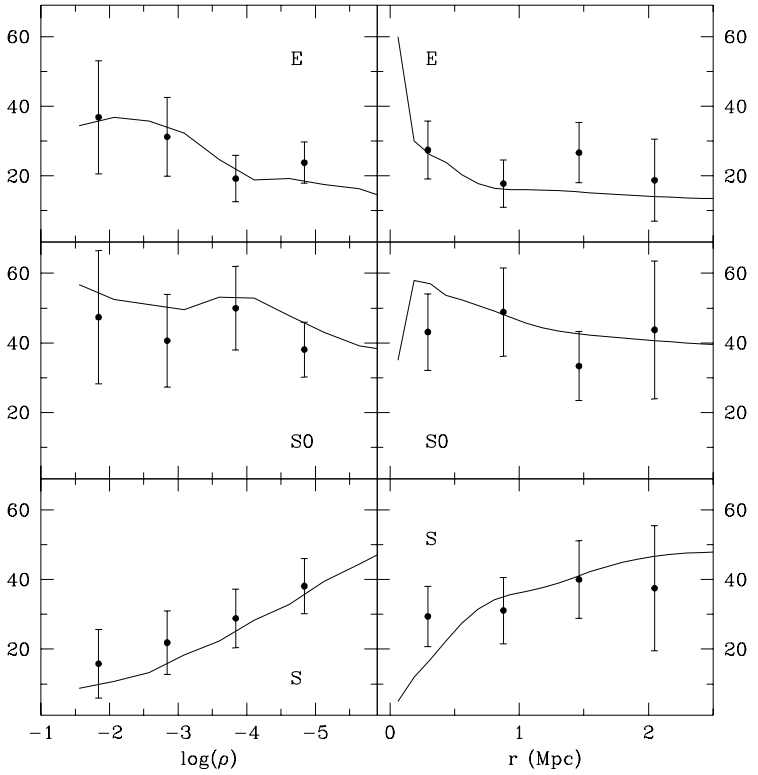

Figure 1: The morphology–density (left panel) and the morphology–clustercentric distance (right panel) relations. Points are relative to our data, whereas lines are the universal relations. See text for details.

(Andreon, Davoust & Heim, 1997).

So, in the three studied clusters, the primary morphological segregation found is the one with respect to the privileged direction and not in density or in distance from the cluster center.

In our three clusters, the privileged direction is roughly aligned with the major axis of the X-ray images (details are in Andreon, Davoust & Heim 1997). Here we do not claim that the elongation of the X-ray emission is the source of a privileged direction in the morphological segregation, but just that there is an approximate coincidence between these two directions. Furthermore, the privileged direction in Coma is also approximatively aligned with the direction

of the NGC4839 group, which could be, in turn, the reason for the existence of the found privileged directions.

This type of segregation cannot be detected in "virtual" clusters formed by "mixing" real ones, as usually done in literature for measuring a morphological segregation, since the superposition of the clusters destroys all azimuthal dependences of the segregations as long as all clusters do not show the same privileged direction in the sky (a pre-copernican hypothesis).

To conclude, in Coma and two other clusters of galaxies the primary morphological segregation is with respect to a privileged direction. Only when this segregation is not considered it appears that the morphological types are segregated in density or in clustercentric distance.

Acknowledgments

I thank L. Buson for an attentive lecture of the manuscript, my former PhD thesis supervisor, E. Davoust and the French Telescope Time Allocation Committee, that allowed such an expensive observational research to be carried out.

References

1. Andreon S. 1994, *A&A* **284**, 801.
2. Andreon S. 1996, *A&A* **314**, 763
3. Andreon S., Davoust E. 1997, *A&A* **319**, 747
4. Andreon S., Davoust E., Heim T., 1997, *A&A* **323**, 337
5. Andreon S., Davoust E., Poulain P., 1997, *A&AS*, **125**, 1
6. Andreon S., Davoust E., Michard R. et al. 1996, *A&AS*, **116**, 429
7. Dressler A. 1980, *ApJ* **236**, 351
8. Dressler A., Oemler A., Couch W., et al. 1997, *ApJ*, in press
9. Hubble E., Humason M., 1926, *ApJ* **64**, 321
10. Sanromà M., Salvador-Solé E., 1990, *ApJ* **360**, 16
11. Smail I., Dressler A., Couch W., et al. 1997, *ApJS* **110**, 213
12. Whitmore B., Gilmore D., Jones C., 1993, *ApJ* **407**, 489